Dispersion and Deposition Modeling An Overview

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Presentation Outline

- Dispersion modeling contribution to RA
- Types of dispersion modeling tools
- Important questions to ask
- Deposition modeling
- Recent improvements in tools
- Uncertainties/caveats

Why use modeling in a risk assessment?

- Allows for source culpability
- Evaluate “what ifs”
- Estimate future air quality
- Provides more spatial information than monitoring alone

Basic types of models

- Eulerian
- Observer “watches the plume go by”

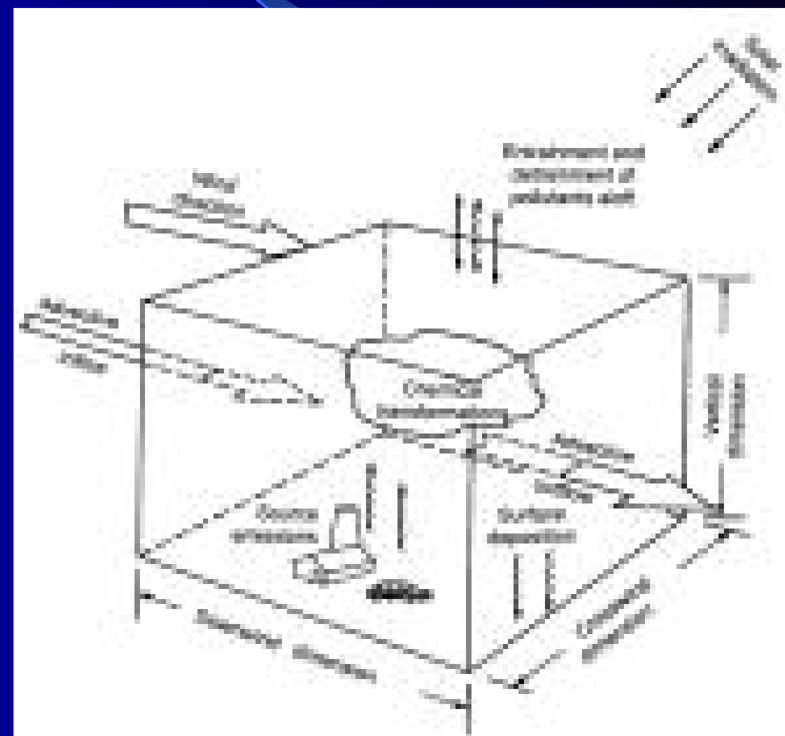
- Lagrangian
- Observer “follows along with the plume”

www.robertbeatty.com

Eulerian Model

Grid models (CMAQ, CAMX, etc.)

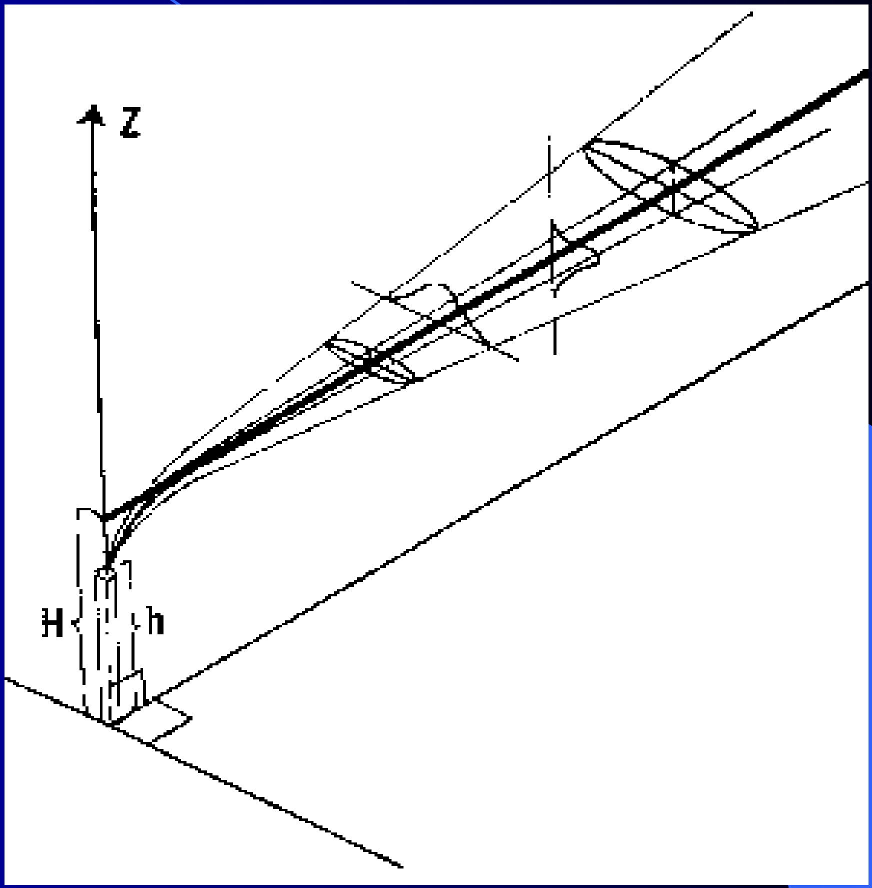
- Chemistry
- Emissions pass through a volume of air



irina.colorado.edu/ lectures/Lec29.htm

Lagrangian Models

- Example is the gaussian plume model, e.g., ISCST3
- Local scale impacts
- Non-reactive pollutants



www.meteo.bg/EURASAP/40/images (Turner, 1970)

Standard examples of Lagrangian models for RA use

- SCREEN3 – simple, easy, conservative screening level model
- ISCST3 – Refined gaussian plume model, commonly used
- CALPUFF – puff model used for complex winds and long range transport
- AERMOD – Proposed to replace ISCST3

Which model should I select?

- Are the pollutants of interest primary or secondary? Are they reactive?
- Are the gases heavier than air (i.e., dense)?
- How large is the area of interest? How far away will we be predicting concentrations?
- Are there significant terrain features (i.e., mountains, hills, valleys)?

Which model should I select? cont.

- Are there nearby buildings that can affect the plume?
- Is there important complex meteorology (i.e., stagnation, valley upslope/downslope flows, channeling)?
- Are multiple pathway exposures a concern (i.e., soil ingestion, fish consumption, etc.)?

Deposition Modeling

- For <u>multiple pathway assessments</u> -

  need to estimate deposition flux values (g/m2/time)

www.cnn.com/2000/ASIANOW/east/09/01/japan.volcano.02/

ISCST3 Deposition

- Requires additional input information
- Meteorological processing
  - Monin-Obukov Length, surface roughness length, albedo, Bowen ratio, anthropogenic heat flux, and net absorbed radiation

ISCST3 Deposition cont.

- Source Inputs
  - Particle and gaseous deposition (wet and dry)
    - Particle size categories
    - Mass fraction in each size category
    - Particle density

ISCST3 Deposition cont.

- Source Inputs
  - Gaseous dry deposition
    - provide vegetation state
    - molecular diffusivity
    - Solubility enhancement factor
    - Pollutant reactivity parameter
    - Mesophyll resistance term
    - Henry’s Law coefficient

Deposition Modeling Improvements

- New deposition algorithms for dry and wet, particles and gases
- For dry gases, old approach is maintained but involves updated techniques
- For dry particles, 2 methods
  - Method 1 if 10% of particles > 10 um diameter
  - Method 2 if less than 10% > 10 um diameter

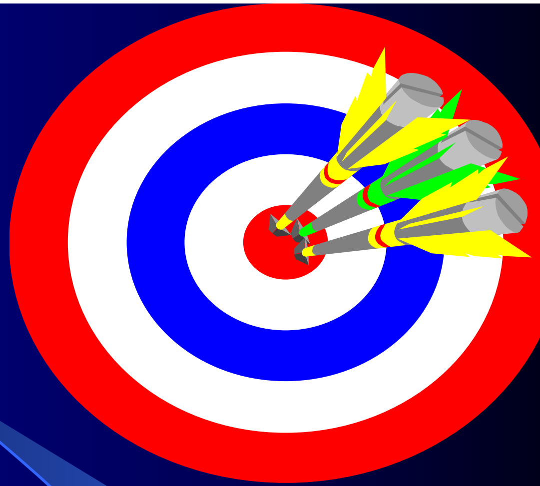
Deposition Modeling Improvements (cont.)

- New approaches for wet deposition of gas and particles
- Model output: concentration, dry dep., wet dep., total dep., conc w/ dep.
- Depletion automatically included
- Will be available in ISCST3 and AERMOD possibly within a month

AERMOD!!!!

- Proposed by EPA to replace ISC for regulatory purposes (4/2000)
- AERMOD performs better than ISCST3 in comparisons with observed data
- Includes updated science and improved techniques to characterize the boundary layer and dispersion
- Possibly finalized by this fall

Uncertainties in Modeling



- Model results represent an ensemble average characterization of an event
- Uncertainties (reducible and non-reducible) are inherent in any model. Must live with and try to minimize
- Important to document the uncertainties, and their potential impacts

General Model Accuracy

- Studies have shown that for dispersion models:
  - A factor of two (+ or –) estimate to observed ratio for ambient air concentrations is considered reasonable
  - Better at longer time-averaged concentrations than for short-term at specific locations
  - Reasonably reliable in estimating the peak concentration occurring sometime, somewhere, within an area. Not as reliable when concentrations are correlated with observed values at a specific time and place

Points to Remember

- Dispersion modeling plays a key role in risk assessment
- Important to select a model that can address your questions/issues
- Deposition flux values needed for multi-pathway assessments.   Requires additional input information
- New deposition algorithms available soon
- AERMOD soon to replace ISCST3